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COMPARATIVE ANALYSIS OF MORPHOFUNCTIONAL PARAMETERS AMONG SEVEN-YEAR-OLD GIRLS LIVING IN DIFFERENT ENVIRONMENTAL CONDITIONS

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Abstract:

Among the issues of paramount importance, a special place is given to the problem of children's health preservation. A modern metropolis with a developed chemical and petrochemical industry has some chemicals in the air that often exceed the maximum permissible norm, and the impact of even a small concentration of harmful substances causes a change in the functioning of body organs and tissues. The danger lies in the fact that a cumulative effect is observed at a relatively low level of biochemically active substance content, leading to the imbalance of organism functioning. This trend of research is of practical importance and is of great scientific and practical interest, since it reflects the general state of morphofunctional indices of children at the age of 7-9 years living in different environmental conditions. Thus, they conducted a comprehensive study of the cardiorespiratory system functions, the anthropometric indicators of seven-year-old girls studying at the first grade of a comprehensive school living in different environmental conditions.

The following methods were used in the study: physiological, biochemical, statistical and the method of directed selection of the studied contingent. Based on the results of the study, the comparative analysis was carried out concerning the results of children living in different environmental conditions. In the process of the performed study, they found out that environmental pollution is one of the causal factors reducing physical development and adaptability of individual systems (cardiovascular, external respiration system) among seven-year-old girls.

Keywords: *heart, anthropometry, cardiorespiratory system.*

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INTRODUCTION:

The sanitary condition of atmospheric air, soil and water is characterized by the entry of a complex of pollutants into the natural environment from industrial enterprises and road transport [1-5]. The main contribution to the pollution of the air basin from stationary sources is performed by heat and power facility, fuel industry, machine building, chemistry and petrochemistry [6-8]. One of the main reasons for the adverse change in the environment is its contamination with various chemical elements, resulting in an excessive intake of chemical compounds into a body [9-15].

Being in a man's body at the concentration above the critical level, toxic substances act on various organs, leading to the change in the general resistance of a body and various disorders in health [16,17]. Chemical pollutants, coming from the environment, are accumulated in a man's body and makes toxic effects even at low concentrations [18-21].

A long-term action of harmful impurities of atmospheric air in small concentrations leads to the development of a specific reaction, manifested by functional shifts in an organism operation [22,23].

It is known that children have special sensitivity to the influence of environmentally unfriendly environmental factors [24]. Literary data indicate that the absorption of toxic elements among children is more active than among adults [25]. A child's organism is characterized by a low threshold of perception to the influence of pollutants, a high reactivity to external influences, and the degree of its adaptive capacities depends on age-sex and a number of other features [26,27]. The cardiovascular system plays the leading role among the systems that ensure the adaptation of an organism to the influence of environmental factors [28].

In order to judge the course of adaptive reactions, about the process of a circulatory system adaptation as a whole to the changing conditions of vital activity and to various stresses, it is necessary to be able to determine the functional state of the various links in a control apparatus.

The most informative indicators in regard to unfavorable environmental factors are the heart rate indicators, which enable us to understand the nature of the current interaction concerning the heart rhythm control links and thereby assess the state and the degree of tension concerning the regulatory mechanisms of a whole organism [29].

The respiratory system, like the cardiovascular system, plays an important role in the maintaining of a body homeostasis [30-32].

Studying the functions of breathing and analyzing the heart rhythm, one can judge about the tension of regulatory processes and about the functional reserves of an organism [33].

The purpose of our work was the comparative analysis of the physical development, the functional status and the adaptive capabilities of the cardiovascular and the respiratory systems of girls of seven-year-old girls living in different environmental conditions.

MATERIALS AND METHODS:

The following methods were used in the study: the method of directed contingent selection, physiological methods, and statistical methods.

The study was conducted at the secondary school №130 in the area of the petrochemical enterprise location, which was chosen as a relatively environmentally unfavorable region (REUR) and at the secondary general school No. 40 located in a relatively environmentally friendly region (REFR) of Kazan.

30 first grade girls took part in the studies. The girls were practically healthy, with an average level of physical development. The survey was conducted in the morning during the whole week.

We formed qualitatively homogeneous groups of children in REUR and REFR for the study. The method of the directed selection of the contingent was used to create homogeneous groups.

In order to study and evaluate the physical development of children (length (H), body weight (M), chest circumference (CC), body surface area) they used the conventional technique by V.V. Bunak.

The study of heart rate variability was carried out using the program based on the method by R.M. Baevsky (1985) [29]. The device of the diagnostic analysis system for electrocardiac signals "Reakard" was used as the device for information input and collection. Based on the results of statistical and autocorrelation analysis of cardio interval dynamic series, heart rate variability indices were calculated.

The assessment of bronchoconstriction was carried out, using the program "Breath Analyzer AD-02M" for the experimental study of the external respiration parameters. The standard values of the Student's criterion were used to determine the reliability.

RESULTS AND DISCUSSIONS:

The conducted studies show that the seven-year-old girls living in REUR received significantly low values of chest circumference (54.94 ± 1.11 cm and 58.27 ± 0.53 cm, $p<0.01$); body length (122.06 ± 1.5 cm and 126.98 ± 0.18 cm, $p<0.01$); body weight (22.75 ± 0.73 kg and 26.7 ± 0.16 kg, $p<0.001$) as compared with the girls living in REFR.

In terms of heart rate among seven-year-old girls living in different environmental conditions, the following results were obtained. The analysis of heart rhythm parameter changes revealed that the heart rate among seven-year-old girls living in the REUR was 104 ± 2.1 beats/min, while the girls of the same age in REFR had the heart rate of 93 ± 4.03 beats/min ($p<0.05$).

The indicator of mode amplitude among seven-year-old girls living in REUR and REFR was 25.5 ± 1.72% and 21.3 ± 1.74% ($p <0.05$), which indicates a higher level of sympathetic autonomic nervous system impact among the children living in REUR. At the same time, the parameters of the variation range among seven-year old girls living in REUR were 247 ± 25.5 ms, while for the girls of the same age living in REFR the variation range was 276 ± 27.7 ms.

The indices of sigma among seven-year-old girls living in REUR made 49.5 ± 4.82 rel. units at rest, while the girls of the same age living in REFR, had higher sigma values by 16.3 ± 1.49 conv. un. and amounted to 65.8 ± 6.61 conv. units, which indicates the shift of vegetative homeostasis towards the predominance of the parasympathetic part of the autonomic nervous system.

The stress index reflects the degree of cardiac rhythm control centralization. This parameter among seven-year-old girls living in REUR was 111 ± 17.5 conv. units, while the girls of the studied age group living in REFR, had the stress index of 76.9 ± 22.1 conv. units.

Thus, the parameters of heart rate among the children under study differ significantly depending on the living conditions, and a reliable reduction of parasympathetic effects on cardiac activity among the children living in REUR may indicate a prolonged adaptive response to unfavorable environmental conditions and lead to the reduction in the reserve and adaptive capabilities of a body.

According to the parameters of external respiration, the following results were obtained. The vital capacity of lungs (VCL) among seven-year-old girls living in the REUR was 1.65 ± 0.05 l, whereas the same indicator among the girls of the studied age living in REFR made 1.76 ± 0.04 l. The indicator of VCL, indicating the degree of pulmonary structure development among the children of the studied age living in the REUR, was slightly lower than among the children living in REFR.

The respiratory volume of seven-year-old girls living in REUR was 0.52 ± 0.01 l at rest, while the girls of the same age in REFR had the respiratory volume at rest slightly higher and it amounted to 0.58 ± 0.03 l.

7-year-old girls living in REUR had the respiratory rate of 12.5 ± 1.06 times/min, which is significantly ($p<0.001$) lower than the respiration rate for the girls living in REFR, which was 18.6 ± 1, 27 times / min.

The minute volume of respiration among seven-year-old girls living in REUR is significantly ($p<0.001$) below 6.49 ± 0.47 l/ min than among the girls of this age living in REFR 10.7 ± 1.03 l/min.

Thus, the studies show a high sensitivity of the external respiration system to anthropogenic impact. Children living in relatively environmentally unfavorable conditions have lower values of the parameters under study as compared to the children living in relatively environmentally friendly conditions.

Thus, the changes in the parameters of the cardiovascular and respiratory systems among seven-year-old girls can reflect complex vegetative rearrangements of an organism during the period of adaptation to ecological living conditions and allow us to judge about the mutual influence of these processes taking into account the dynamics of the studied system functional state.

CONCLUSIONS:

1. The children of primary school age who live in REUR have lower rates of physical development, as compared with children living in REFR. 7 year old girls living in REUR showed significantly low H ($p <0.01$), as well as significantly low CO values ($p <0.01$) and reliably low M ($p <0.001$).
2. 7-year-old girls living in REUR, had the changes in the parameters of the variation pulsogram (HBR, S; ΔX; AMO; IN), indicating the decrease of an organism adaptation degree. Thus, at the age of 7 the girls have a statistically significant increase in heartbeat rate, which corresponds to a significant decrease of σ-sigma ($p<0,05$) and ΔX, as well as the increase of AMO indicators - the mode amplitude ($p<0,05$) and IN.
3. The change in the values of external respiration parameters (VCL, DO, RF, RMV) among the children living in REUR indicates the strain of body functional reserves and the decrease of organism adaptation degree among the children of the age under study residing in different environmental conditions.

SUMMARY:

The obtained results allow drawing the conclusion that the revealed features of the indicators concerning the physical development of girls living in ecologically unfavorable conditions are consistent with the data of a number of studies.

So a number of authors (Dautov, 1990, Romanova, 2001, etc.) revealed the changes in the indicators of the physical development among children, depending on the degree of air pollution from industrial

enterprises. Given that the surveyed contingent of children was formed on the principle of "vapor copy", and also that children were not exposed to production factors, did not have bad habits and most of the time they were at the children's institutions that have the same conditions and regime, one can come to the conclusion about the negative impact of environmental pollution on the physical development of children of the age under study.

The obtained results of heartbeat rate indicators among seven-year-old girls living in different environmental conditions allow us to conclude that children in relatively environmentally unfavorable conditions have more pronounced sympathetic effects of heartbeat rate control mechanisms, and the activity of the parasympathetic system is decreased (the decrease of ΔX, σ; AMO, IN increase).

Such shifts indicate the strain of regulatory mechanisms of heartbeat rate control. A significant decrease in parasympathetic influences on cardiac activity among the children living in REUR may indicate a prolonged adaptive response to unfavorable environmental conditions and lead to the reduction of organism adaptive capability reserves among the children of the age under study, which is consistent with the research of a number of authors (Shlyk, 1992, Romanova, 2001 and others).

The revealed features of external respiration indicators among the girls of primary school age living in different environmental conditions, allow us to conclude that children in relatively environmentally unfavorable conditions are marked with lower values of the parameters as compared with the children living in relatively environmentally friendly conditions, which confirms the conclusion on the high sensitivity of the external respiration system to anthropogenic impact.

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